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**REPORT OF PARTICULATE/PM-10 EMISSION TESTING ON THE BAGHOUSE
EXHAUST DUCTS OF BOILER #B28 & #B09 AT THE MANITOWOC PUBLIC
UTILITIES LOCATED IN MANITOWOC, WISCONSIN**

Prepared for:

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STACK TEST GROUP, INC. PROJECT NO. 12-2244

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1.0 EXECUTIVE SUMMARY

On April 17 & 19, 2012, The Stack Test Group, Inc. performed particulate/PM-10 testing at the Manitowoc Public Utilities (MPU) located in Manitowoc, Wisconsin. Testing was conducted on the baghouse exhaust ducts of boilers #B28 & #B09. Three tests were conducted on these boilers for the above listed parameter. Presented below are the average results of these three tests.

Boiler #B28:

Particulate Concentration:	9.52×10^{-7} Pounds per DSCF
Particulate Emission Rate:	4.36 Pounds per Hour
Particulate Emission Rate:	0.399 Pounds per Ton Coal
Particulate Emission Rate (F-Factor):	0.013 Pounds per MMBTU
PM-10 Concentration:	1.78×10^{-6} Pounds per DSCF
PM-10 Emission Rate:	8.13 Pounds per Hour
PM-10 Emission Rate:	0.745 Pounds per Ton Coal
PM-10 Emission Rate (F-Factor):	0.025 Pounds per MMBTU

Boiler #B09:

Particulate Concentration:	6.96×10^{-7} Pounds per DSCF
Particulate Emission Rate:	5.04 Pounds per Hour
Particulate Emission Rate:	0.196 Pounds per Ton Coal
Particulate Emission Rate (F-Factor):	0.009 Pounds per MMBTU
PM-10 Concentration:	1.39×10^{-6} Pounds per DSCF
PM-10 Emission Rate:	10.05 Pounds per Hour
PM-10 Emission Rate:	0.392 Pounds per Ton Coal
PM-10 Emission Rate (F-Factor):	0.017 Pounds per MMBTU

2.0 INTRODUCTION

The Stack Test Group, Inc. conducted particulate/PM-10 emission testing on the baghouse exhaust ducts of the #B28 & #B09 boilers. Testing was performed at Manitowoc Public Utilities located in Manitowoc Wisconsin on April 17 & 19, 2012. Three tests were conducted on these boilers for the above mentioned parameters. The purpose of this testing was to determine the concentrations and emissions rates of the particulate matter/PM-10 exhausting from the #B28 and #B09 boilers.

Testing was conducted while MPU personnel operated the two boilers at maximum continuous steam rating (MCR). The LB/MMBTU emissions were calculated using the heat input of the boilers and using the F-Factor. Operating data such as steam flow, baghouse pressure drops, opacity, flue temperatures, etc. may be found in Appendix E.

Testing was supervised by Mr. Gary A. Kohnke of the Stack Test Group, Inc., and coordinated by Mr. Tom Reed of Manitowoc Public Utilities.

All testing followed the guidelines of U.S. EPA Reference Methods 1 through 5 and 202. This report contains a summary of results for the above mentioned tests and all the supporting field, process, and computer generated data.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

3.1 Exhaust Gas Parameters

3.1.1 Traverse and Sampling Points

Testing was conducted at the exhaust ducts of boilers #B28 & #B09. The number of velocity traverse and sample measurement points for each was determined using EPA Method 1.

Boiler #B28:

The inside duct diameter measures 124.5 inches by 60 inches. The equivalent diameter of the duct is 80.98 inches. The test ports are located greater than two equivalent diameters downstream and greater than 0.5 equivalent diameters upstream from the nearest flow disturbances. Velocity and sample measurements will be taken at each of 25 points, 5 points in each of the five ports set horizontally to each other.

Boiler #B09:

The inside duct diameter measures 108 inches. The test ports are located greater than two equivalent diameters downstream and greater than 0.5 equivalent diameters upstream from the nearest flow disturbances. Velocity and sample measurements will be taken at each of 24 points, 12 points in each of the two ports set at 90° to each other.

3.1.2 Velocity Traverse

Velocity measurements were performed during each emission test in accordance with EPA Method 2. An "S" type Pitot Tube with an attached type "K" thermocouple was used to conduct the velocity traverse.

3.1.3 Gas Composition

Gas composition for oxygen, carbon dioxide, and nitrogen was determined employing EPA Method 3. An integrated gas sample was collected during each emission test. Gas analysis was conducted using a calibrated Servomex O2/CO2 analyzer.

3.1.4 Moisture Content

The exhaust gas moisture content was determined using EPA Method 4 for all tests. Moisture content was determined by drawing the gas sample through the impingers in the sample train. Volumetric analysis was used to measure the condensed moisture in the first three impingers while gravimetric analysis of silica gel was used to measure moisture collected in the fourth impinger.

3.2 Particulate/PM-10

3.2.1 Sample Collection

Particulate/PM-10 emissions were determined following the guidelines of USEPA Reference Methods 1, 2,3,4,5 and 202. These Methods are titled:

Method 1	Sample and Velocity Traverses for Stationary Sources
Method 2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type "S" Pitot Tube)
Method 3	Gas Analysis for Carbon Dioxide, Oxygen, Excess Air and Dry Molecular Weight
Method 4	Determination of Moisture Content from Stationary Sources
Method 5	Determination of Particulate Emissions from Stationary Sources
Method 202	Determination of Condensable Particulate Emissions from Stationary Sources (Dry Impinger Method)

These methods appear in detail in Title 40 of the Code of Federal Regulations (CFR), Part 60, Appendix A.

The Method 5/202 sampling train consisted of the following components.

1. Appropriately sized nozzle.
2. Glass lined probe heated to $248 \pm 25^{\circ}\text{F}$.
3. Heated glass fiber filter to $248 \pm 25^{\circ}\text{F}$.
4. Condenser, Drop out Impinger, 2 Modified Greenburg-Smith Impingers, Teflon CPM Filter in a dual insulated ice water bath in the following sequence:
 - A. Method 202 Vertical Condenser.
 - B. Method 23 Knockout Impinger.
 - C. Modified Greenburg-Smith Impinger Empty.
 - D. Glass Filter Assembly Containing Teflon Filter (65° - 85°F).
 - E. Modified Greenburg-Smith Impinger with 100 mls of Water.
 - F. Known Amount of Silica Gel.
5. Sampling gas measuring system.

3.2.2 Sample Duration and Frequency

Three Method 5/202 train samples were collected with each test lasting at least 125 minutes in duration on boiler #B28 and 120 minutes in duration on boiler #B09. A minimum sample size of 60 dry standard cubic feet (dscf) was collected for each test.

3.2.3 Sample Recovery

Upon completion of each test the sampling train was removed from the stack. The probe, nozzle, and prefilter glassware were rinsed and brushed with acetone and placed into a labeled container. The filter was placed into a separate container.

The impingers were purged for one-hour with nitrogen at a rate of approximately 15 liters per minute. The impingers were weighed for moisture gain. The contents of the impingers were placed into a separate container along with the DI rinses of the impingers. The impingers were then rinsed with acetone and hexane and placed into a separate container. The CPM filter was placed in a separate container.

3.2.4 Analytical Procedures

The total particulate mass was determined by adding the weight of the particulate from the prefilter wash with the particulate on the filter. This was added to the condensable particulate weight.

The acetone wash containing the particulate from the prefilter wash was placed into a tared beaker, evaporated to dryness, desiccated for 24 hours, and then weighed in 6 hour intervals to a constant weight. An acetone blank was also analyzed and subtracted from the particulate weight of the acetone wash.

The tared glass fiber filter was desiccated for 24 hours, and then weighed every six hours to constant weight.

The condensable particulates were analyzed according to the procedures outlined in method 202. The result of this analysis produces two independent fractions, the organic and the inorganic fractions. These results are reported separately in the field parameter sheets and the weight sheets in the laboratory data appendix.

3.2.5 Blanks

Blinks for the Method 5/202 train were prepared by recovering an acetone, water and a hexane sample in the same manner listed above.

3.2.6 Calibrations

All sampling equipment was calibrated according to the procedures outlined in EPA Reference Method 5/202.

4.0 TEST RESULTS

Presented in this section are the results of this test series. Test results are reported in Tables 4.1 and 4.2. Table 4.1 reports the stack gas conditions for Boiler #B28 exhaust including stack gas temperature, percent carbon dioxide and oxygen, percent moisture, molecular weight of the stack gas dry and wet, velocity in feet per second (fps), and flow rate in actual cubic feet per minute (acfmin), standard cubic feet per minute (scfm), and dry standard cubic feet per minute (dscfm).

Tables 4.1 also present the particulate/PM-10 results. The particulate/PM-10 results are presented in terms of grains per dry standard cubic feet (grains/DSCF), pounds per dry standard cubic feet (lb/dscf), pounds per hour (lb/hr), pounds per million British Thermal Units (lb/MMBTU) based on F-Factor and pounds per ton of fuel.

Table 4.2 presents the results for the boiler #B09 testing. The test results are presented in the same manner and format as Table 4.1.

Copies of the calculations used to determine these emission rates may be found in Appendix A. Copies of the field data sheets are presented in Appendix B. Copies of boiler fuel analytical results are presented in Appendix C. Copies of equipment calibrations are presented in Appendix E.

Table 4.1

Particulate (PM) Results
Manitowoc Public Utilities
Manitowoc, WI
04/19/12

Boiler #B28 Baghouse Exhaust

Test No:	T1	T2	T3	Avg.
Start Time:	08:15 AM	11:16 AM	01:35 PM	
Finish Time:	10:23 AM	01:24 PM	03:43 PM	
Stack Gas Temperature, degrees F:	299.68	301.28	299.24	300.1
% Carbon Dioxide:	13.2	13.4	13.4	13.3
% Oxygen:	6.3	6.1	6.2	6.2
% Moisture:	7.22	7.64	7.24	7.37
Molecular Weight dry, lb/lb-Mole:	30.36	30.39	30.39	30.38
Molecular Weight wet, lb/lb-Mole:	29.47	29.44	29.49	29.47
Velocity and Flow Results:				
Average Stack Gas Velocity FPS:	40.64	40.87	40.88	40.80
Stack Gas Flow Rate, ACFM:	126,504	127,220	127,251	126,992
Stack Gas Flow Rate, SCFM:	82,076	82,367	82,609	82,351
Stack Gas Flow Rate, DSCF/HR:	4,569,021	4,564,465	4,597,675	4,577,054
Stack Gas Flow Rate, DSCFM:	76,150	76,074	76,628	76,284
Filterable Particulate Results:				
Grains Per DSCF:	0.0083	0.0057	0.0060	0.0067
LBS/DSCF:	1.18E-06	8.18E-07	8.58E-07	9.52E-07
LBS/HR:	5.401	3.732	3.944	4.359
LBS/MMBTU (F-Factor = 9,895.1):	0.017	0.011	0.012	0.013
LBS/Ton of coal:	0.495	0.342	0.361	0.399
Total Particulate Results:				
Grains Per DSCF:	0.0125	0.0129	0.0119	0.0124
LBS/DSCF:	1.79E-06	1.85E-06	1.70E-06	1.78E-06
LBS/HR:	8.16	8.43	7.81	8.13
LBS/MMBTU (F-Factor = 9,895.1):	0.025	0.026	0.024	0.025
LBS/Ton of coal:	0.747	0.772	0.715	0.745

Table 4.2

Particulate (PM) Results
Manitowoc Public Utilities
Manitowoc, WI
04/17/12

Boiler #B09 Baghouse Exhaust

Test No:	T1	T2	T3	Avg.
Start Time:	07:50 AM	10:10 AM	12:32 PM	
Finish Time:	09:57 AM	12:18 PM	02:39 PM	
Stack Gas Temperature, degrees F:	338.38	340.04	345.42	341.3
% Carbon Dioxide:	14.8	14.8	14.5	14.7
% Oxygen:	4.5	4.5	5.0	4.7
% Moisture:	8.00	7.59	7.86	7.81
Molecular Weight dry, lb/lb-Mole:	30.55	30.55	30.52	30.54
Molecular Weight wet, lb/lb-Mole:	29.55	29.60	29.54	29.56
Velocity and Flow Results:				
Average Stack Gas Velocity FPS:	51.34	52.30	54.28	52.64
Stack Gas Flow Rate, ACFM:	195,975	199,640	207,198	200,937
Stack Gas Flow Rate, SCFM:	128,220	130,346	134,332	130,966
Stack Gas Flow Rate, DSCF/HR:	7,077,734	7,227,185	7,426,413	7,243,777
Stack Gas Flow Rate, DSCFM:	117,962	120,453	123,774	120,730
Filterable Particulate Results:				
Grains Per DSCF:	0.005	0.005	0.005	0.005
LBS/DSCF:	7.73E-07	6.63E-07	6.52E-07	6.96E-07
LBS/HR:	5.473	4.790	4.844	5.036
LBS/MMBTU (F-Factor = 9,697.7):	0.010	0.008	0.008	0.009
LBS/Ton of coal:	0.205	0.191	0.193	0.196
Total Particulate Results:				
Grains Per DSCF:	0.010	0.010	0.009	0.010
LBS/DSCF:	1.45E-06	1.39E-06	1.33E-06	1.39E-06
LBS/HR:	10.25	10.02	9.89	10.05
LBS/MMBTU (F-Factor = 9,697.7):	0.018	0.017	0.017	0.017
LBS/Ton of coal:	0.384	0.399	0.393	0.392

APPENDIX A
EXAMPLE CALCULATIONS

SAMPLE CALCULATIONS

The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

1. Volume of water collected (wscf)

$$V_{wstd} = (0.04707)(V_{lc})$$

Where:

V_{lc}	total volume of liquid collected in impingers and silica gel (ml)
V_{wstd}	volume of water collected at standard conditions (ft^3)
0.04707	conversion factor (ft^3/ml)

2. Volume of gas metered, standard conditions (dscf)

$$V_{mstd} = \frac{(17.64)(V_m)\left(P_{bar} + \frac{\Delta H}{13.6}\right)(Y_d)}{(460 + T_m)}$$

Where:

P_{bar}	barometric pressure (in. Hg)
T_m	average dry gas meter temperature ($^{\circ}\text{F}$)
V_m	volume of gas sample through the dry gas meter at meter conditions (ft^3)
V_{mstd}	volume of gas sample through the dry gas meter at standard conditions (ft^3)
Y_d	gas meter correction factor (dimensionless)
ΔH	average pressure drop across meter box orifice (in. H_2O)
17.64	conversion factor ($^{\circ}\text{R}/\text{in. Hg}$)
13.6	conversion factor (in. $\text{H}_2\text{O}/\text{in. Hg}$)
460	$^{\circ}\text{F}$ to $^{\circ}\text{R}$ conversion constant

3. Sample gas pressure (in. Hg)

$$P_s = P_{bar} + \left(\frac{P_g}{13.6}\right)$$

Where:

P_{bar}	barometric pressure (in. Hg)
P_g	sample gas static pressure (in. H_2O)
P_s	absolute sample gas pressure (in. Hg)
13.6	conversion factor (in. $\text{H}_2\text{O}/\text{in. Hg}$)

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SAMPLE CALCULATIONS (CONTINUED)

4. Actual vapor pressure (in. Hg)¹

$$P_v = P_s$$

Where:

P _v	vapor pressure, actual (in. Hg)
P _s	absolute sample gas pressure (in. Hg)

5. Moisture content (%)

$$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$$

Where:

B _{wo}	proportion of water vapor in the gas stream by volume (%)
V _{mstd}	volume of gas sample through the dry gas meter at standard conditions (ft ³)
V _{wstd}	volume of water collected at standard conditions (ft ³)

6. Saturated moisture content (%)

$$B_{ws} = \frac{(P_v)}{(P_s)}$$

Where:

B _{ws}	proportion of water vapor in the gas stream by volume at saturated conditions (%)
P _s	absolute sample gas pressure (in. Hg)
P _v	vapor pressure, actual (in. Hg)

Whichever moisture value is smaller is used for B_{wo} in the following calculations.

7. Molecular weight of dry gas stream (lb/lb·mole)

$$M_d = M_{CO_2} \frac{(CO_2)}{(100)} + M_{O_2} \frac{(O_2)}{(100)} + M_{CO+N_2} \frac{(CO + N_2)}{(100)}$$

Where:

M _d	dry molecular weight of sample gas (lb/lb·mole)
M _{CO₂}	molecular weight of carbon dioxide (lb/lb·mole)
M _{O₂}	molecular weight of oxygen (lb/lb·mole)
M _{CO+N₂}	molecular weight of carbon monoxide and nitrogen (lb/lb·mole)
CO ₂	proportion of carbon dioxide in the gas stream by volume (%)
O ₂	proportion of oxygen in the gas stream by volume (%)
CO+N ₂	proportion of carbon monoxide and nitrogen in the gas stream by volume (%)
100	conversion factor (%)

¹ For effluent gas temperatures over 212°F, P_v is assumed to be equal to P_s.

SAMPLE CALCULATIONS (CONTINUED)

8. Molecular weight of sample gas (lb/lb·mole)

$$M_s = (M_d)(1 - B_{wo}) + (M_{H_2O})(B_{wo})$$

Where:

B_{wo}	proportion of water vapor in the gas stream by volume
M_d	dry molecular weight of sample gas (lb/lb·mole)
M_{H_2O}	molecular weight of water (lb/lb·mole)
M_s	molecular weight of sample gas, wet basis (lb/lb·mole)

9. Velocity of sample gas (ft/sec)

$$V_s = (K_p)(C_p) \left(\frac{\sqrt{\Delta P}}{\sqrt{(M_s)(P_s)}} \right) \left(\sqrt{\frac{(T_s + 460)}{460}} \right)$$

Where:

K_p	velocity pressure coefficient (dimensionless)
C_p	pitot tube constant
M_s	molecular weight of sample gas, wet basis (lb/lb·mole)
P_s	absolute sample gas pressure (in. Hg)
T_s	average sample gas temperature (°F)
V_s	sample gas velocity (ft/sec)
$\sqrt{\Delta P}$	average square roots of velocity heads of sample gas (in. H ₂ O)
460	°F to °R conversion constant

10. Total flow of sample gas (acfmin)

$$Q_a = (60)(A_s)(V_s)$$

Where:

A_s	cross sectional area of sampling location (ft ²)
Q_a	volumetric flow rate at actual conditions (acfmin)
V_s	sample gas velocity (ft/sec)
60	conversion factor (sec/min)

11. Total flow of sample gas (dscfm)

$$Q_{std} = \frac{(Q_a)(P_s)(17.64)(1 - B_{wo})}{(T_s + 460)}$$

Where:

B_{wo}	proportion of water vapor in the gas stream by volume
P_s	absolute sample gas pressure (in. Hg)
Q_a	volumetric flow rate at actual conditions (acfmin)
Q_{std}	volumetric flow rate at standard conditions, dry basis (dscfm)
T_s	average sample gas temperature (°F)
17.64	conversion factor (°R/in. Hg)
460	°F to °R conversion constant

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SAMPLE CALCULATIONS (CONTINUED)

12. Percent isokinetic (%)

$$I = \frac{(0.09450)(\bar{T}_s + 460)(V_{mstd})}{(P_s)(V_s)\left(\frac{(D_n)^2(\pi)}{(144)(4)}\right)(\Theta)(1 - B_{wo})}$$

Where:

D _n	diameter of nozzle (in)
B _{wo}	proportion of water vapor in the gas stream by volume
I	percent of isokinetic sampling (%)
P _s	absolute sample gas pressure (in. Hg)
T _s	average sample gas temperature (°F)
V _{mstd}	volume of gas sample through the dry gas meter at standard conditions (ft ³)
V _s	sample gas velocity (ft/sec)
Θ	total sampling time (min)
0.09450	constant
460	°F to °R conversion constant

13. Particulate concentration (gr/dscf)

$$C_{gr/dscf} = \frac{(15.43)(m_n)}{V_{mstd}}$$

Where:

C _{gr/dscf}	measured concentration in the gas stream (gr/dscf)
m _n	total amount of particulate matter collected, corrected for applicable reagent blank (g)
V _{mstd}	volume of gas sample through the dry gas meter at standard conditions (ft ³)
15.43	conversion factor (gr/g)

14. Particulate emission (lb/hr)

$$E_{lb/hr} = \frac{(C_{gr/dscf})(Q_{std})(60)}{7,000}$$

Where:

C _{gr/dscf}	measured concentration in the gas stream (gr/dscf)
E _{lb/hr}	emission rate (lb/hr)
Q _{std}	volumetric flow rate at standard conditions, dry basis (dscfm)
60	conversion factor (min/hr)
7,000	conversion factor (gr/lb)

APPENDIX B
FIELD DATA SHEETS

Location: MPC
Unit: Boiler B8 EH. Run: 1

FIELD DATA SHEET

Particulate Testing Method 5/302 Page 1 of 1

Client: <u>MPA</u>	Meter Lk Ck Pre: <u>.003</u> @ <u>18"</u>				Bar. Press. (in. Hg): <u>.99.33</u>		
Plant: <u>Man, Helvetic, UCF</u>	Meter Lk Ck Post: <u>.002</u> @ <u>10"</u>				Probe ID No.: <u>STC-10</u>		
Meter Operator: <u>KLC</u>	Pitot Lk Ck: + <u>0</u> @ <u>4.1-</u> @ <u>"</u>				Liner Material: <u>Alumina</u>		
Probe Operator: <u>TP</u>	Start Time (approx.): <u>8:15</u>				Nozzle Dia.: <u>.289</u>		
Date: <u>4-19-12</u>	Stop Time (approx.): <u>10:23</u>				O ₂ (dry, vol. %): <u>.30%</u>		
Meter Box No.: <u>55</u>	Static Press. (in. H ₂ O): <u>-19.1</u>				CO ₂ (dry, vol. %): <u>13.2%</u>		
Y _d : <u>.475</u> ΔH: <u>1.774</u>	Port Length (in.): <u></u>				H ₂ O (condensate, ml): <u>116</u> ml/s		
K Factor: <u>.5, 2</u>	First Point (all the way), (in)/(out)				Duct Dimensions (in.): L/ <u>Y/SW</u> <u>6.0</u>		
					H ₂ O (silica gel, g): <u>12.0</u>		

Transverse Point Number	Min/PT	Pitot As. (in. H ₂ O)	Sample As. (in. H ₂ O)	Manometer Vol (ft)	Probe Temp Set Point	Stack Temp Ts (°F)	Dry Gas Meter Tm (°F)	Filter Temp Set Point	Exit Temp Ts (°F)	Pump Vac (in. Hg)	Notes
1A	.5	.35	1.8	76.81	230	242	254	44	2.5	.67	
2	.10	.34	1.8	280.12	247	248	242	45	2.5	.68	
3	.15	.34	1.8	283.37	250	20	263	46	3.0	.69	
4	.20	.35	1.8	286.58	253	292	261	46	3.0	.69	
5	.25	.33	1.7	289.83	251	289	262	46	3.0	.69	
1B	.30	.36	1.9	293.14	248	298	260	46	3.0	.69	
2	.35	.35	1.8	296.32	251	302	262	46	3.0	.69	
3	.40	.35	1.8	299.57	253	303	261	46	3.0	.70	
4	.45	.34	1.8	302.86	250	303	264	46	3.0	.70	
5	.50	.31	1.6	306.06	253	300	264	48	4.0	.70	
1C	.55	.37	1.9	309.36	249	301	261	46	4.0	.70	
2	.60	.37	1.9	312.62	252	398	267	50	4.0	.71	
3	.65	.35	1.8	315.87	250	203	61	50	4.0	.72	
4	.70	.35	1.8	319.10	250	303	61	52	4.0	.73	
5	.15	.35	1.8	322.38	251	304	62	54	4.0	.75	
1D	.20	.36	1.9	325.69	252	300	62	54	4.0	.76	
2	.25	.36	1.9	328.98	251	303	62	54	4.0	.76	
3	.30	.35	1.8	332.23	254	300	63	55	4.0	.76	
4	.35	.35	1.8	335.50	250	304	63	55	4.0	.76	
5	.40	.33	1.7	338.70	251	292	63	56	4.0	.76	
1E	.45	.31	1.6	341.91	253	300	68	57	4.0	.77	
2	.50	.35	1.8	345.17	250	303	68	56	4.0	.78	
3	.55	.36	1.9	348.47	253	304	67	57	4.0	.79	
4	.60	.34	1.9	351.75	254	301	67	57	4.0	.83	
5	.05	.36	1.9	355.05	252	294	67	57	4.0	.83	
Total											
Avg.	<u>5841</u>	<u>1.8840</u>			<u>399.68</u>	<u>7336</u>					

Location: in P.M.
Unit: Biology Dept. Exh.

FIELD DATA SHEET

Unit: Biology Run: 2

FIELD DATA SHEET

Client:	<u>MPU</u>	Meter Lk Ck Pre:	<u>002</u>	@	<u>14</u>	"
Plant:	<u>Min. twice MIT</u>	Meter Lk Ck Post:	<u>.001</u>	@	<u>10</u>	"
Meter Operator:	<u>Alf</u>	Pt0!Lk Ck:	<u>+ .0</u>	@	<u>4.9</u>	- .0 @ C. "1
Probe Operator:	<u>Tony</u>	Start Time (approx.):	<u>11.16</u>			
Date:	<u>4-19-12</u>	Stop Time (approx.):	<u>1:24</u>			
Meter Box No.:	<u>55</u>	Static Press. (in. H2O):	<u>-19.0</u>			
X _{dt} :	<u>.975</u>	Port Length (in.):				
ΔH:	<u>1.74</u>	First Point (all the way):	<u>yrf (out)</u>			
K Factor:	<u>2</u>					Dur

Traverse point Number	Min/Pt.	Ptot ΔP	Sample ΔH	Metered Vol. (ml)	Probe Temp: Str Set Point
1	1.0	(1)(H ₂ O)	(H ₂ O)	356.00	

Bar. Press. (in. Hg):	24.33
Probe ID No.:	ST 6-10
Liner Material:	Glass
Nozzle Dia.:	.029
O ₂ (dry, vol. %):	6.1 %
CO ₂ (dry, vol. %):	13.4 %
H ₂ O (condensate, ml):	1.2 ml
H ₂ O (silica gel, g):	14.0 g
ct Dimensions (in.): L/H/W: SW: 6D	

Location: MPU Box: 3
 Unit: Bldg #8 Enh. Run: 3

FIELD DATA SHEET

Client: MPU Meter Lk Ck Pre: .00.2 @ 12" Particulate Testing Method 5/202 Page 1 of 1

Plant: <u>Montauk, UT</u>	Meter Lk Ck Post: <u>.00.2</u> @ <u>10"</u>			Bar. Press. (In. Hg): <u>29.33</u>
Meter Operator: <u>RK</u>	Pilot Lk Ck: <u>+ .0</u> @ <u>3.7 - 0</u> @ <u>6.0"</u>			Probe ID No.: <u>STC-10</u>
Probe Operator: <u>TP</u>	Start Time (approx.): <u>1:35</u>			Liner Material: <u>Glass</u>
Date: <u>4-19-12</u>	Stop Time (approx.): <u>3:43</u>			Nozzle Diam.: <u>.209</u>
Meter Box No.: <u>55</u>	Static Press. (In. H2O): <u>-19.1</u>			O ₂ (dry, vol. %): <u>6.2%</u>
Y _c : <u>.475</u> ΔH: <u>1.774</u>	Port Length (in.): <u></u>			CO ₂ (dry, vol. %): <u>13.4%</u>
K Factor: <u>5.2</u>	First Point (all the way): <u>yes</u> (out)			H ₂ O (condensate, ml): <u>116.615</u>
		Duct Dimensions (in.): <u>4.24x5W 6.0</u>	H ₂ O (silica gel, g): <u>14.5g</u>	

Traverse point Number	Min/Pt. Elevation (ft)	Pitot Alt. (ft)	Sample Alt. (ft)	Metered Vol. (ft ³)	Probe Temp. (°F)	Stack Temp. (°F)	Dry Gas Meas. Time (s)	Filter Temp. (°F)	Exit Temp. (°F)	Pump Vac. (in Hg)	Notes
1A	.05	33	1.7	441.69	280	69	64	260	54	5.0	65
2	10	34	1.9	446.09	252	300	74	64	254	5.0	66
3	15	35	1.8	449.34	253	300	75	64	267	5.0	66
4	20	35	1.8	451.59	252	75	63	256	49	5.0	65
5	25	36	1.9	455.90	250	76	64	263	48	5.0	66
1B	30	38	2.0	459.31	253	301	76	64	259	47	5.0
2	35	37	1.9	469.62	254	306	76	63	272	47	5.0
3	40	35	1.8	465.89	253	301	75	63	261	47	5.0
4	45	35	1.5	469.11	253	300	76	64	263	47	5.0
5	50	34	1.8	472.37	254	389	77	64	260	48	5.0
1C	55	35	1.5	475.63	254	303	78	64	258	48	5.0
2	60	36	1.9	478.96	255	301	77	64	255	48	5.0
3	65	35	1.9	482.33	255	302	77	64	256	49	5.0
4	70	35	1.8	485.57	254	300	77	64	256	50	5.0
5	75	37	1.9	488.98	254	289	78	64	258	50	5.0
1D	80	35	1.8	492.33	252	304	76	63	260	50	5.0
2	85	33	1.7	495.47	255	306	77	64	261	51	5.0
3	90	33	1.7	498.67	255	303	77	64	267	51	5.0
4	95	34	1.8	501.88	253	300	76	64	255	51	5.0
5	100	36	1.9	505.09	252	300	76	63	256	52	5.0
1E	105	37	1.9	508.29	252	302	76	63	261	51	5.0
2	110	35	1.8	511.49	255	302	76	63	264	52	5.0
3	115	35	1.8	515.73	254	303	77	63	260	51	5.0
4	120	35	1.8	518.52	255	300	76	63	261	51	5.0
5	125	33	1.7	521.74	254	297	76	63	260	50	5.0
Total											
Avg.	<u>59.29</u>	<u>1.82</u>			<u>269.24</u>			<u>169.78</u>			

Location: MPLC
Unit: Boiler #9 Run: 809

FIELD DATA SHEET

Particulate Testing Method M5/20² Page 1 of 3

Client: Monitrac, WI	Meter Lk Ck Pre: .001 @ 7 "								
Plant: Monitrac U+Ht.s	Meter Lk Ck Post: .001 @ 10 "								
Meter Operator: TP	Pilot Lk Ck: +,0 @ 4.1 - ,0 @ 6.0								
Probe Operator: TP	Start Time (approx.): 7:50 AM								
Date: 4-17-12	Stop Time (approx.): 9:57 AM								
Meter Box No.: 55	Static Press. (in. H2O): -30								
γ_d : 975 ΔH : 1.774	Port Length (in): 11 1/2"								
K Factor: 2.5	First Point (all the way)(in) (out)			Duct Dimensions (in): 108"					
		H ₂ O (silica gel, g):		14.09					

Traversed Point	Min/Pt	Pilot AP	Sample AP	Mass of Vg. Al	Mass of Vg. Pt	Pilot Temp	Stable Temp	Dry Gas Meter in	Meter out	Filter Temp	Exit Temp	Prin. Vol.	Notes
Name#	Elapsed time (in H2O)			(in H2O)	008 72	(°F)	(°F)	(in)	(in)	Set Point			
1	.5	.57	1.4	.11.95	260	342	51	49	258	48	4.0	65	
2	10	.57	1.4	.14.87	263	339	63	49	260	43	4.0	67	
3	15	.55	1.4	.17.57	262	337	63	48	257	42	4.0	67	
4	20	.55	1.4	.20.52	261	237	67	48	257	42	4.0	67	
5	.54	1.4	023.46	260	336	65	49	254	42	4.0	67		
6	30	.55	1.4	.16.78	261	326	66	50	255	42	4.0	67	
7	35	.57	1.4	.029.31	261	336	67	51	257	43	4.0	68	
8	40	.56	1.4	.032.24	259	336	67	52	258	43	4.0	68	
9	45	.54	1.4	.035.15	259	336	67	52	258	43	4.0	68	
10	50	.55	1.4	.038.08	261	337	68	54	256	43	4.0	68	
11	.55	.54	1.4	.040.98	259	337	69	54	256	43	4.0	69	
12	1:00	.55	1.4	.043.99/43.07	261	337	69	55	254	43	4.0	69	
1	1:05	.55	1.4	.045.32	261	337	69	55	254	44	4.0	69	
2	1:10	.55	1.4	.049.86	255	338	69	54	254	43	4.0	69	
3	1:15	.56	1.4	.052.71	251	338	70	56	254	43	4.0	69	
4	1:20	.57	1.4	.055.62	250	338	70	57	252	44	4.0	69	
5	1:25	.57	1.4	.058.55	252	339	71	57	258	45	4.0	70	
6	1:30	.57	1.4	.061.47	257	333	71	58	251	45	4.0	70	
7	1:35	.56	1.4	.064.50	260	340	70	59	257	46	4.0	70	
8	1:40	.57	1.4	.067.34	259	342	71	59	251	47	4.0	70	
9	1:45	.57	1.4	.070.26	210	341	71	59	251	47	4.0	71	
10	1:50	.58	1.5	.073.32	258	341	70	59	256	47	4.0	71	
11	1:55	.57	1.4	.076.38	260	342	71	59	256	47	4.0	71	
12	2:00	.58	1.5	.071.36	260	342	71	60	256	47	4.0	71	
Total													
Avg.	.7483	1.4083						338.38		61.17			

Location: MPU**FIELD DATA SHEET**Unit: B09 Run: 2Particle Size Testing Method M5 D² Page 2 of 3

Client: <u>Moilin Inc., WI</u>	Meter Lk Ck Pre: <u>Q21 @ 9 "</u>	Meter Lk Ck Post: <u>Q002 @ 14 "</u>	Bar. Press. (in. Hg): <u>29.62</u>
Plant: <u>MPU</u>	Meter Lk Ck Post: <u>Q002 @ 14 "</u>	Pitot Lk Ck: <u>+7 @ 3.0 "</u>	Probe ID No.: <u>STL-A</u>
Meter Operator: <u>TP</u>	Pitot Lk Ck: <u>+7 @ 3.0 "</u>	Liner Material: <u>Glass</u>	Nozzle Dia.: <u>.242</u>
Probe Operator: <u>TP</u>	Start Time (approx.): <u>10:10 AM</u>	O ₂ (dry, vol. %): <u>4.5%</u>	O ₂ (dry, vol. %): <u>4.5%</u>
Date: <u>9-17-12</u>	Stop Time (approx.): <u>12:18 PM</u>	CO ₂ (dry, vol. %): <u>14.8%</u>	CO ₂ (dry, vol. %): <u>14.8%</u>
Meter Box No.: <u>55</u>	Static Press. (in. H ₂ O): <u>- .31</u>	H ₂ O (condensate, ml): <u>106 ml</u>	
Y _d : <u>.725</u> ΔH: <u>1.774</u>	Port Length (in.): <u>11.1</u> "		
K Factor: <u>2.5</u>	First Point (all the way): <u>(in)(out)</u>	Duct Dimensions (in.): <u>10.8</u> "	H ₂ O (silica gel, g): <u>.05 g</u>

Traverse Point Number	Min/Pt. Endpt. (in.)	Pitot T.P.	Sample A.H.	Metered Vol. (ft ³)	Probe Temp: Set Point (°F)	Stadi m	Dry Gas Meter Vol. (ft ³)	Filter Temp: Set Point (°F)	Exit Temp: Set Point (°F)	Point Vol. (in H ₂ O)	Notes: A.H. & V _d
1	5	.59	1.5	083.19	252	33.7	63	58	264	41	4.0
2	10	.63	1.6	086.41	256	343	71	59	155	40	4.0
3	15	.63	1.6	089.55	257	343	71	60	255	42	4.0
4	20	.64	1.6	092.71	257	343	70	60	355	43	4.0
5	25	.63	1.6	095.88	259	342	72	60	251	44	4.0
6	30	.61	1.5	098.99	259	341	70	60	260	45	4.0
7	35	.59	1.5	102.06	259	341	70	60	258	45	4.0
8	40	.57	1.5	105.13	257	340	70	60	257	45	4.0
9	45	.58	1.5	108.19	257	339	69	60	258	46	4.0
10	50	.56	1.5	111.25	255	339	68	60	256	46	3.0
11	55	.55	1.5	114.32	255	339	68	60	256	47	3.0
12	60	.55	1.5	117.37	112.64	355	7	339	68	60	255
1	1.05	.57	1.5	120.67	258	331	68	60	255	46	3.0
2	1.10	.56	1.5	123.73	257	339	68	58	256	46	3.0
3	1.15	.56	1.5	126.87	257	339	69	58	255	47	3.0
4	1.20	.55	1.5	129.81	256	339	70	59	259	50	3.0
5	1.25	.57	1.5	132.79	258	339	69	59	258	51	3.0
6	1.30	.58	1.5	135.85	257	339	69	59	259	51	3.0
7	1.35	.58	1.5	138.15	254	339	70	59	259	51	3.0
8	1.40	.57	1.5	141.92	257	340	70	60	257	52	3.0
9	1.45	.57	1.5	144.95	256	340	70	60	255	54	3.0
10	1.50	.59	1.5	147.98	257	340	70	60	256	56	3.0
11	1.55	.57	1.5	151.33	154	341	68	61	257	54	3.0
12	1.60	.55	1.5	154.08	157	341	68	60	258	48	3.0
Total					260	341	68	60	258	47	3.0
Avg.	.7622	.57			340.04	341.51					3.0

Location: MPU1**FIELD DATA SHEET**Unit: B11, R#9 Ech Bm Run: 3Particulars Testing Method 5/102 Page 1 of 1

Client:	<u>MPU1</u>	Mater Lk Ck Pre:	<u>.001 @ 7"</u>	Bar. Press. (in. Hg):	<u>26.62</u>
Plant:	<u>Plant 1</u>	Mater Lk Ck Post:	<u>.001 @ 5"</u>	Probe ID No.:	<u>ST6-70A</u>
Meter Operator:	<u>MPU1</u>	Pilot Lk Ck:	<u>+.0 @ 4.0 - .0 @ 5.0</u>	Liner Material:	<u>Copper</u>
Probe Operator:	<u>TP</u>	Start Time (approx.):	<u>12:33 PM</u>	Nozzle Dia.:	<u>.243</u>
Date:	<u>4-17-17</u>	Stop Time (approx.):	<u>2:39 PM</u>	O ₂ (dry, vol. %):	<u>5.0%</u>
Meter Box No.:	<u>55</u>	Static Press. (in. H ₂ O):	<u>—, 35</u>	CO ₂ (dry, vol. %):	<u>14.5%</u>
Y _d :	<u>.975</u>	Port Length (in.):	<u>11.5"</u>	H ₂ O (condensate, ml):	<u>190ml</u>
K Factor:	<u>.5</u>	First Point (all the way)/ <u>(in)</u> (out)	<u>Duct Dimensions (in.): 105"</u>	H ₂ O (silica gel, g):	<u>13.5g</u>

Trans. Point Number	M.U.P.H. (in. Hg)	Pilot AP (in. Hg)	Stagn. AP (in. Hg)	Measuring Vol. (in. Hg)	Probe Temp Set Point	Stagn. Temp Set Point	Dry Gas Meter Flow	Filter Temp Set Point	Exit Temp Set Point	Pump Vac.	Notes	
1	.5	.57	1.4	127.50	345	61	58	260	44	5.0	69	
2	.0	.56	1.5	160.51	353	67	58	262	43	9.0	70	
3	.15	.59	1.5	163.51	356	67	58	263	45	9.0	72	
4	.10	.57	1.4	166.47	357	68	58	260	45	4.0	72	
5	.25	.54	1.4	169.44	356	343	67	59	260	45	4.0	72
6	.30	.57	1.4	173.39	357	344	66	58	260	45	4.0	73
7	.35	.57	1.4	175.33	356	344	67	58	264	44	4.0	75
8	.40	.61	1.5	178.36	358	344	68	58	261	45	4.0	76
9	.45	.61	1.5	181.40	358	343	68	38	262	45	4.0	78
10	.50	.66	1.7	184.61	357	343	69	58	261	45	4.0	78
11	.55	.65	1.6	187.31	358	344	69	59	260	45	5.0	79
12	1.00	.64	1.6	191.03/191.3	360	344	70	59	262	46	5.0	79
13	.5	.63	1.6	194.25	358	344	71	60	264	46	5.0	79
14	.10	.65	1.6	197.47	256	347	67	60	262	44	3.0	79
15	.15	.63	1.6	200.06	255	348	68	59	264	45	5.0	80
16	.20	.66	1.7	203.17	258	341	68	59	259	47	5.0	80
17	.25	.65	1.6	207.37	257	350	68	59	265	46	5.0	80
18	.30	.64	1.6	210.75	254	350	66	59	258	47	5.0	78
19	.35	.66	1.7	213.14	256	349	66	58	258	47	5.0	78
20	.40	.65	1.6	216.11	258	350	66	58	260	47	5.0	78
21	.45	.65	1.6	220.09	254	344	64	58	262	47	5.0	79
22	.50	.64	1.6	223.28	256	348	65	57	264	47	5.0	79
23	.55	.63	1.6	226.59	256	347	61	57	262	47	5.0	79
24	.60	.63	1.6	229.07	255	348	66	57	260	47	5.0	80
Total												
Avg.												

APPENDIX C
ANALYTICAL RESULTS

STACK TEST GROUP, INC.
PARTICULATE WEIGHT SHEET

Client:	Manitowoc Public Utilities	Acetone # :	020110A
Source:	Baghouse Exhaust Stack B-28	Acetone Blank:	<0.1 mg
Test Date:	19-Apr-12		

FRONT 1/2

	<u>T1</u>	<u>T2</u>	<u>T3</u>
Filter			
Filter Tare Weight :	356.0	360.2	355.5
Filter Final Weight: 04/27 @ 10:10	374.8	373.9	372.3
05/01 @ 13:35	375.2	374.1	372.6
Average Final Wt.:	375.0	374.0	372.5
Filter Gain:	19.0	13.8	17.0
Beaker			
Beaker Tare Weight:	115,150.1	99,903.4	101,666.4
Beaker Final Weight: 05/01 @ 13:26	115,172.7	99,918.3	101,680.0
06/21 @ 16:05	115,172.5	99,918.3	101,680.0
Average Final Wt.:	115,172.6	99,918.3	101,680.0
Beaker Gain:	22.5	14.9	13.6
Total Weight	41.5	28.7	30.6

STACK TEST GROUP, INC.
PARTICULATE WEIGHT SHEET

Client:	Manitowoc Public Utilities	Acetone # :	020110A
Source:	Baghouse Exhaust Stack B28	Acetone Blank:	<0.1 mg
Test Date:	19-Apr-12	MeCL Blank:	<0.1mg

Organic Fraction

	<u>T1</u>	<u>T2</u>	<u>T3</u>
Beaker			
Beaker Tare Weight:	118,046.6	104,405.3	101,481.6
Beaker Final Weight: 05/01 @ 13:30	118,056.2	104,413.7	101,490.2
05/11 @ 08:21	118,056.0	104,413.4	101,490.2
Average Final Wt.:	118,056.1	104,413.6	101,490.2
Beaker Gain:	9.5	8.3	8.6
Total Weight	9.5	8.3	8.6

STACK TEST GROUP, INC.
PARTICULATE WEIGHT SHEET

Client:	Manitowoc Public Utilities	Acetone # :	020110A
Source:	Baghouse Exhaust Stack B28	Acetone Blank:	<0.1 mg
Test Date:	19-Apr-12	Hexane Blank:	<0.1mg

Aqueous Fraction

	<u>T1</u>	<u>T2</u>	<u>T3</u>
Beaker			
Beaker Tare Weight:	103,621.1	126,598.1	123,950.3
Beaker Final Weight: 05/01 @ 13:33	103,632.9	126,625.8	123,971.8
05/11 @ 08:21	103,632.7	126,625.9	123,971.6
Average Final Wt.:	103,632.8	126,625.9	123,971.7
Beaker Gain:	11.7	27.8	21.4
Total Weight	11.7	27.8	21.4

STACK TEST GROUP, INC.
PARTICULATE WEIGHT SHEET

Client:	Manitowoc Public Utilities	Acetone # :	020110A
Source:	Baghouse Exhaust Stack B-09	Acetone Blank:	<0.1 mg
Test Date:	17-Apr-12		

FRONT 1/2

	<u>T1</u>	<u>T2</u>	<u>T3</u>
Filter			
Filter Tare Weight :	362.5	358.5	361.3
Filter Final Weight: 04/27 @ 10:01	372.9	367.7	372.2
05/01 @ 13:50	372.6	368.0	372.4
Average Final Wt.:	372.8	367.9	372.3
Filter Gain:	10.3	9.4	11.0
Beaker			
Beaker Tare Weight:	112,200.2	100,385.7	105,442.3
Beaker Final Weight: 05/01 @ 13:38	112,214.3	100,398.1	105,453.0
05/11 @ 09:01	112,214.1	100,398.0	105,453.2
Average Final Wt.:	112,214.2	100,398.1	105,453.1
Beaker Gain:	14.0	12.4	10.8
Total Weight	24.3	21.8	21.8

STACK TEST GROUP, INC.
PARTICULATE WEIGHT SHEET

Client:	Manitowoc Public Utilities	Acetone # :	020110A
Source:	Baghouse Exhaust Stack B09	Acetone Blank:	<0.1 mg
Test Date:	17-Apr-12	MeCL Blank:	<0.1mg

Organic Fraction

	<u>T1</u>	<u>T2</u>	<u>T3</u>
Beaker			
Beaker Tare Weight:	107,308.4	108,668.5	119,957.3
Beaker Final Weight: 05/01 @ 13:43	107,317.7	108,678.5	119,967.0
05/11 @ 09:06	107,317.6	108,678.1	119,966.8
Average Final Wt.:	107,317.7	108,678.3	119,966.9
Beaker Gain:	9.3	9.8	9.6
Total Weight	9.3	9.8	9.6

STACK TEST GROUP, INC.
PARTICULATE WEIGHT SHEET

Client:	Manitowoc Public Utilities	Acetone # :	020110A
Source:	Baghouse Exhaust Stack B-09	Acetone Blank:	<0.1 mg
Test Date:	17-Apr-12	Hexane Blank:	<0.1mg

Aqueous Fraction

	<u>T1</u>	<u>T2</u>	<u>T3</u>
Beaker			
Beaker Tare Weight:	100,899.0	100,022.1	105,603.2
Beaker Final Weight: 05/01 @ 13:46	100,911.0	100,036.2	105,616.3
05/11 @ 09:14	100,910.8	100,036.0	105,616.3
Average Final Wt.:	100,910.9	100,036.1	105,616.3
Beaker Gain:	11.9	14.0	13.1
Total Weight	11.9	14.0	13.1

APPENDIX D
FIELD PARAMETER SHEETS

STACK TEST GROUP, INC.
Air Quality Services

Particulate Sampling Train Calculations

Client:	Manitowoc Public Utilities			
Project No:	12-2244			
Date:	04/19/12			
Source:	Boiler #B28 Exhaust			
Test No:	<u>T1</u>	<u>T2</u>	<u>T3</u>	<u>Avg.</u>
Start Time	08:15 AM	11:16 AM	01:35 PM	
Finish Time	10:23 AM	01:24 PM	03:43 PM	
Pilot Cal. Factor	0.84	0.84	0.84	
Meter Calibration Factor:	0.975	0.975	0.975	
Stack Length, inches:	124.5	124.5	124.5	
Stack Width, inches:	60	60	60	
Stack Diameter, inches:	0	0	0	
Nozzle Diameter, inches:	0.289	0.289	0.289	
Barometric Pressure, Inches Hg:	29.33	29.33	29.33	
Static Pressure in Stack, Inches H2O:	-19.1	-19	-19.1	
Duration of Sample, minutes:	125	125	125	
Meter Start Volume:	273,560	356,000	439,500	
Meter Final Volume:	355,050	438,060	521,740	
Average Meter Pressure, Inches H2O:	1.80	1.82	1.82	1.8147
Average Meter Temperature, degrees F:	73.4	77.3	69.8	73.5
Average Sqrt. Velocity Pressure:	0.5891	0.5915	0.5929	0.5912
Stack Gas Temperature, degrees F:	299.68	301.3	299.2	300.1
% Carbon Dioxide:	13.2	13.4	13.4	13.3
% Oxygen:	6.3	6.1	6.2	6.2
% Carbon Monoxide:	0.0	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	128	136	130.5	132
Total Weight of Particulate, Mg (Filterable):	41.5	28.7	30.6	33.6
Total Weight of Particulate, Mg (Condensable)	21.2	36.1	30.0	29.1

Sample Train Calculations

Meter Volume, Actual:	81.490	82,060	82.240	81.930
Meter Volume, STP:	77.415	77,394	78.662	77.824
Volume of Water Vapor Condensed:	6,025	6,402	6,143	6,190
Total Gas Sampled:	83,440	83,795	84,804	84,013
% Moisture:	7.22	7.64	7.24	7.37
Area of Stack, Square Feet:	51.88	51.88	51.88	51.88
% Excess Air at Test Location:	42.1	40.3	41.3	41.2
Molecular Weight dry, lb/lb-Mole:	30.36	30.39	30.39	30.38
Molecular Weight wet, lb/lb-Mole:	29.47	29.44	29.49	29.47
Absolute Stack Gas Pressure, In Hg:	27.93	27.93	27.93	27.93
Isokinetic, %:	92.7	92.7	93.6	93.0

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	40.64	40.87	40.88	40.80
Stack Gas Flow Rate, ACFM:	126,504	127,220	127,251	126,992
Stack Gas Flow Rate, SCFM:	82,076	82,367	82,609	82,351
Stack Gas Flow Rate, DSCF/HR:	4,569,021	4,564,465	4,597,675	4,577,054
Stack Gas Flow Rate, DSCFM:	76,150	76,074	76,628	76,284

Particulate Calculations (Filterable):

Grains Per DSCF:	0.0083	0.0057	0.0060	0.0067
LBS/DSCF:	1.18E-06	8.18E-07	8.58E-07	9.52E-07
LBS/HR:	5.40	3.73	3.94	4.36
LBS/MMBTU (F-Factor = 9,895.1):	0.017	0.011	0.012	0.013
LBS/Ton of coal:	0.495	0.342	0.361	0.399

Particulate Calculations (Condensables):

Grains Per DSCF:	0.0042	0.0072	0.0059	0.0058
LBS/DSCF:	6.04E-07	1.03E-06	8.41E-07	8.24E-07
LBS/HR:	2.76	4.69	3.87	3.77
LBS/MMBTU (F-Factor = 9,895.1):	0.009	0.014	0.012	0.012
LBS/Ton of coal:	0.253	0.430	0.354	0.346

Particulate Calculations (Total):

Grains Per DSCF:	0.012	0.013	0.012	0.0124
LBS/DSCF:	1.79E-06	1.85E-06	1.70E-06	1.78E-06
LBS/HR:	8.16	8.43	7.81	8.13
LBS/MMBTU (F-Factor = 9,895.1):	0.025	0.026	0.024	0.025
LBS/Ton of coal:	0.747	0.772	0.715	0.745

STACK TEST GROUP, INC.
Air Quality Services

Particulate Sampling Train Calculations

Client:	Manitowoc Public Utilities			
Project No:	12-2244			
Date:	04/17/12			
Source:	Boiler #B09 Exhaust			
Test No:	<u>T1</u>	<u>T2</u>	<u>T3</u>	<u>Avg.</u>
Start Time	07:50 AM	10:10 AM	12:32 PM	
Finish Time	09:57 AM	12:18 PM	02:39 PM	
Pitot Cal. Factor	0.84	0.84	0.84	
Meter Calibration Factor:	0.975	0.975	0.975	
Stack Length, inches:	0	0	0	
Stack Width, inches:	0	0	0	
Stack Diameter, inches:	108	108	108	
Nozzle Diameter, inches:	0.242	0.242	0.242	
Barometric Pressure, inches Hg:	29.62	29.62	29.62	
Static Pressure in Stack, Inches H2O:	-0.3	-0.31	-0.35	
Duration of Sample, minutes:	120	120	120	
Meter Start Volume:	8.720	79.720	154.340	
Meter Final Volume:	79.360	154.080	229.670	
Average Meter Pressure, Inches H2O:	1.41	1.52	1.55	1.4933
Average Meter Temperature, degrees F:	61.2	64.3	62.7	62.7
Average Sqrt. Velocity Pressure:	0.7483	0.7622	0.7874	0.7660
Stack Gas Temperature, degrees F:	338.38	340.0	345.4	341.3
% Carbon Dioxide:	14.8	14.8	14.5	14.7
% Oxygen:	4.5	4.5	5.0	4.7
% Carbon Monoxide:	0.0	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	128	126.5	133.5	129
Total Weight of Particulate, Mg (Filterable):	24.3	21.8	21.8	22.6
Total Weight of Particulate, Mg (Condensable):	21.2	23.8	22.7	22.6

Sample Train Calculations

Meter Volume, Actual:	70.640	74.360	75.330	73.443
Meter Volume, STP:	69.287	72.524	73.701	71.837
Volume of Water Vapor Condensed:	6.025	5.954	6.284	6.088
Total Gas Sampled:	75.312	78.479	79.995	77.925
% Moisture:	8.00	7.59	7.86	7.81
Area of Stack, Square Feet:	63.62	63.62	63.62	63.62
% Excess Air at Test Location:	26.8	26.8	30.8	28.1
Molecular Weight dry, lb/lb-Mole:	30.55	30.55	30.52	30.54
Molecular Weight wet, lb/lb-Mole:	29.55	29.60	29.54	29.56
Absolute Stack Gas Pressure, in Hg:	29.60	29.60	29.59	29.60
Isokinetic, %:	97.6	100.0	98.9	98.8

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	51.34	52.30	54.28	52.64
Stack Gas Flow Rate, ACFM:	195.975	199.640	207.198	200.937
Stack Gas Flow Rate, SCFM:	128,220	130,346	134,332	130,966
Stack Gas Flow Rate, DSCF/HR:	7,077,734	7,227,185	7,426,413	7,243,777
Stack Gas Flow Rate, DSCFM:	117,962	120,453	123,774	120,730

Particulate Calculations (Filterable):

Grains Per DSCF:	0.0054	0.0046	0.0046	0.0049
LBS/DSCF:	7.73E-07	6.63E-07	6.52E-07	6.96E-07
LBS/HR:	5.47	4.79	4.84	5.04
LBS/MMBTU (F-Factor = 9,697.7):	0.010	0.008	0.008	0.009
LBS/Ton of coal:	0.205	0.191	0.193	0.196

Particulate Calculations (Condensables):

Grains Per DSCF:	0.0047	0.0051	0.0048	0.0048
LBS/DSCF:	6.75E-07	7.24E-07	6.79E-07	6.92E-07
LBS/HR:	4.78	5.23	5.04	5.02
LBS/MMBTU (F-Factor = 9,697.7):	0.008	0.009	0.009	0.009
LBS/MMBTU (Heat Input):	0.007	0.008	0.007	0.007
LBS/Ton of coal:	0.179	0.208	0.201	0.196

Particulate Calculations (Total):

Grains Per DSCF:	0.010	0.010	0.009	0.0097
LBS/DSCF:	1.45E-06	1.39E-06	1.33E-06	1.39E-06
LBS/HR:	10.25	10.02	9.89	10.05
LBS/MMBTU (F-Factor = 9,697.7):	0.018	0.017	0.017	0.017
LBS/Ton of coal:	0.384	0.399	0.393	0.392

APPENDIX E
CALIBRATIONS

STACK TEST GROUP, INC. Nozzle Calibration Data

Client: Manitowoc Public Utilities Date: 4/17 & 19/2012
Plant: Manitowoc, WI Calibrated by: G.Kohnke
Unit Number: See Below
Runs: Method 5.202 Tests 1-3

Nozzle Identification	Nozzle Diameter ^a			D ^b (inches)	Davg. ^c (inches)
	D1 (inches)	D2 (inches)	D3 (inches)		
Baghouse B28	0.289	0.289	0.290	0.001	0.289
Baghouse B09	0.241	0.243	0.242	0.002	0.242

Where:

D1,D2, D3 = The three nozzle diameter measurements. All diameters must be measured to 0.001 inches.

D = Maximum difference between any two diameters. D <= 0.004 inches.

Davg. = average of D1, D2, D3

APEX INSTRUMENTS
 522 Series Meter Box Calibration
 EPA Method 5
 Pre-Test Orifice Method
 English Meter Box Units, English K' Factor
 Model #: Apex Method 5
 Serial #: 55
 Date: 7/21/95 Version: 2.2
 Revised: 7/21/95
 Barometric Pressure: 29.60 (in. Hg)
 Theoretical Critical vacuum: 13.96 (in. Hg)

Filenames: C:\Documents and Settings\Chris\My Documents\meter cal\155 10-28-11.yz=969.xls|55 8-9-07

!!!!!! For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.
 !!!!!!! IMPORTANT The Critical Orifice Coefficient, K', must be entered in English units, $(ft)^3 \cdot (\deg R)^{0.5} / ((in. lg)^2 \cdot (min))$.
 !!!!!!!

----- DRY GAS METER READINGS -----

dh _{H2O} (in H ₂ O)	Time (min)	Volume Initial (cu ft)	Volume Final (cu ft)	Total Inlet (cu ft)	Initial Temps, Inlet (deg F)	Final Temps, Outlet (deg F)	Inlet Orifice (deg F)	Final Temperature	Orifice K' Orifice Coefficient (number) (see above)	Serial#	Actual - Ambient Temperature
0.05	11.00	709.250	710.300	5.050	59.0	60.0	59.0	24.0	CJ46	0.350	68.0
1.10	9.00	710.300	715.800	5.500	59.0	61.0	60.0	23.0	CJ55	0.161	69.0
1.90	7.00	716.250	721.730	5.100	61.0	60.0	61.0	0.590	CJ63	0.590	69.0
3.50	5.00	722.150	727.520	5.370	63.0	61.0	63.0	21.0	CJ73	0.821	68.0
5.20	4.00	726.250	733.510	5.260	65.0	62.0	65.0	19.0	CJ01	1.012	68.0
								58.0			68.0

***** RESULTS *****

--- DRY GAS METER ---

----- ORIFICE -----

--- DRY GAS METER ---

----- DRIFICE -----

--- DRY GAS METER ---

----- DRIFICE -----

Stack Test Group

Pitot Tube Calibration Sheet

Client Manitowoc Public Utilities
Plant Manitowoc, WI
Pitot ID STG-10A

External Tubing Diameter 0.375 inches
Base To Opening Plane Distance(P_a) 0.513 inches
Base To Opening Plane Distance(P_b) 0.513 inches
Pitot Coefficient 0.84

	Measured	Allowable
P_a/D_t	1.383	1.05-1.50
P_b/D_t	1.385	1.05-1.50
Angle α °	0.0	10.0
Angle α' °	0.0	10.0
Angle β °	0.0	5.0
Angle β' °	0.0	5.0
z (inches)	0	0.125 in.
w(inches)	0.000	0.031 in.

Signature G. Kohnke

Date 3/12/2012

Pyrometer Calibration Sheet

STG Project No. 12-2244

Client: Manitowoc Public Utilities
Manitowoc, WI

Date: 4/17 & 19/2012

Date Calibrated: 3/12/2012

Temperature Scale Used: °F

Probe No. STG 10-A

Reference Used: Mercury Thermometer

Calibration Reference Settings °F	Pyrometer Reading °F
32	31
65	65
212	211

Calibrated by: B. Byczynski

APPENDIX F
BOILER FIELD DATA SHEETS

Boiler Stack Test Operating Data								
Date: April 19, 2012	Boiler: B-28		Recorded by: Thomas E. Reed					
Test: PM	Run: No. 1		Testing by: Stack Test Group, Inc.					
Methods: USEPA Methods 1, 2, 3, 4, 5, 202, 40CFR Part 60, Appendix A								
Parameter	Start	Mid	Stop	AVG. Net				
Time	8:15	9:16	10:21	2:06				
Coal Scale B (lbs.)	147889		170642	22,753				
Coal Scale A (lbs.)	408849		431942	23,093				
Pounds of Fuel Used				45,846				
Pounds of fuel per hour				21,831				
Limestone Scale (lbs)	701359		717075	15,716				
Steam integrator(Klbs)	936.34		1348.00	411.66				
Limestone (Klbs/hr)	5.6	6.9	8.7	7.1				
Steam Flow (Klbs/hr)	187.7	192.9	199.1	193.2				
Percent of MCR	94%	96%	100%	98%				
Feed Water (Klbs/hr)	179.7	181.5	190.4	183.9				
Plant Master (psig)	855	848	861	854.7				
Differential freeboard	6.35	6.57	6.92	6.61				
Bed Temperature	1609	1613	1625	1616				
Bed Level	20.80	20.46	20.90	20.72				
Total Air Flow (Klb/hr)	210.5	213.8	216.1	213.5				
PA Air Flow (Klb/hr)	157	160	158	158				
Overfire Air (Klbs/hr)	20.5	20.4	24.6	21.8				
Boiler (out) Temp.	506	504	505	505				
A.H. (out) Temp.	321	322	321	321				
Bag house dp (inches)	4.72	5.31	4.82	4.95				
Opacity (%)	3.13	3.38	3.28	3.26				
Carbon Monoxide ppm	20.5	22.6	35.2	26.1				
Soot Blowing	---	---	---					
Gross MW	21.19	22.33	22.59	22.04				
Gross MWh Generation	2797.9		2844.3	46.40				
MPU Fireman:	Evan Moen							
NOTES: 1. Steam integrator value from Trend #5, or use F4 and then TST. B8 graphic is 8.								
2. Turbine #6 online with live steam to PRV.								

Boiler Stack Test Operating Data								
Date: April 19, 2012	Boiler: B-28		Recorded by: Thomas E. Reed					
Test: PM	Run: No. 2		Testing by: Stack Test Group, Inc.					
Methods: USEPA Methods 1, 2, 3, 4, 5, 202, 40CFR Part 60, Appendix A								
Parameter	Start	Mid	Stop	AVG. Net				
Time	11:16	12:15	13:25	2:09				
Coal Scale B (lbs.)	180358		204153	23,795				
Coal Scale A (lbs.)	441819		466027	24,208				
Pounds of Fuel Used				48,003				
Pounds of fuel per hour				22,327				
Limestone Scale (lbs)	724299		735912	11,613				
Steam integrator(Klbs)	1535.29		1971.88	436.59				
Limestone (Klbs/hr)	4.5	5.5	4.4	4.8				
Steam Flow (Klbs/hr)	207.8	204.2	198.6	203.5				
Percent of MCR	104%	102%	99%	102%				
Feed Water (Klbs/hr)	199.9	197.0	190.6	195.8				
Plant Master (psig)	862	855	856	857.7				
Differential freeboard	8.30	8.07	8.10	8.16				
Bed Temperature	1628	1622	1608	1619				
Bed Level	17.71	19.83	19.92	19.15				
Total Air Flow (Klb/hr)	228.7	228.9	219.9	225.8				
PA Air Flow (Klb/hr)	169	167	166	167				
Overfire Air (Klbs/hr)	28.0	27.9	22.5	26.1				
Boiler (out) Temp.	514	507	501	507				
A.H. (out) Temp.	327	321	318	322				
Bag house dp (inches)	4.72	4.83	4.68	4.74				
Opacity (%)	3.15	3.27	3.56	3.33				
Carbon Monoxide ppm	26.4	28.0	25.0	26.5				
Soot Blowing	---	---	---					
Gross MW	23.4	23.2	22.6	23.1				
Gross MWh Generation	2864.9		2915.4	50.50				
MPU Fireman:	Evan Moen							
NOTES: 1. Steam integrator value from Trend #5, or use F4 and then TST. B8 graphic is 8.								
2. Turbine #6 online with live steam to PRV.								

Boiler Stack Test Operating Data								
Date: April 19, 2012	Boiler: B-28	Recorded by: Thomas E. Reed						
Test: PM	Run: No. 3	Testing by: Stack Test Group, Inc.						
Methods: USEPA Methods 1, 2, 3, 4, 5, 202, 40CFR Part 60, Appendix A								
Parameter	Start	Mid	Stop	AVG. Net				
Time	13:35	14:43	15:42	2:07				
Coal Scale B (lbs.)	205992		229247	23,255				
Coal Scale A (lbs.)	467871		491492	23,621				
Pounds of Fuel Used				46,876				
Pounds of fuel per hour				22,146				
Limestone Scale (lbs)	736709		748368	11,659				
Steam integrator(Klbs)	2008.28		2433.98	425.70				
Limestone (Klbs/hr)	5.1	5.4	5.9	5.5				
Steam Flow (Klbs/hr)	200.4	203	202.3	201.9				
Percent of MCR	100%	102%	101%	101%				
Feed Water (Klbs/hr)	192.4	196.1	193.7	194.1				
Plant Master (psig)	850	856	855	853.7				
Differential freeboard	7.89	7.67	8.01	7.86				
Bed Temperature	1608	1613	1619	1613				
Bed Level	20.33	20.17	19.50	20.00				
Total Air Flow (Klb/hr)	223.3	225.5	219.3	222.7				
PA Air Flow (Klb/hr)	166	166	166	166				
Overfire Air (Klbs/hr)	22.5	26.8	26.4	25.2				
Boiler (out) Temp.	501	505	501	502				
A.H. (out) Temp.	318	318	318	318				
Bag house dp (inches)	4.87	4.84	4.92	4.88				
Opacity (%)	2.9	2.9	2.8	2.9				
Carbon Monoxide ppm	25.3	27.0	24.6	25.6				
Soot Blowing	2:55							
Gross MW	22.5	22.9	22.8	22.7				
Gross MWh Generation	2918.3		2966.8	48.50				
MPU Fireman:	Evan Moen followed by Rick Mlesiva							
NOTES: 1. Steam integrator value from Trend #5, or use F4 and then TST. B8 graphic is 8.								
2. Turbine #6 online with live steam to PRV.								

Boiler Stack Test Operating Data								
Date: April 17, 2012	Boiler: B-09	Recorded by: Thomas E. Reed						
Test: PM	Run: No. 1	Testing by: Stack Test Group, Inc.						
Methods: USEPA Methods 1, 2, 3, 4, 5, 202, 40CFR Part 60, Appendix A								
Parameter	Start	Mid	Stop	Avg. Net				
Time	7:50	9:00	9:57	2:07				
Coal Scale (A.)	4963597		5001568	37,971				
Coal Scale (B.)	415169		452764	37,595				
Coal Scale (C.)	204395		241771	37,376				
Total Pounds of Fuel				112,942				
Pounds of fuel per hour				53,358				
Limestone (Klbs/hr)	7.9	8.9	13.0	9.9				
Limestone Scale (lbs)	252435		272121	19,686				
MW Totals (MWh)	58973.6		59103.3	129.7				
Output (MWh-gross)	54.65	61.78	63.1	59.84				
Steam Flow (Klbs/hour)	469	481	500	483				
Percent of MCR	99%	101%	105%	102%				
Feed Water (Klbs/hr)	454	464	484	467				
Boiler Master (psig)	1457.8	1464.5	1468.0	1463.4				
Fuel Master (Klbs/hr)	53.6	53.1	52.5	53.1				
Differential Freeboard	7.9	8.5	9.0	8.5				
Bed Temperature (F)	1625	1657	1673	1652				
Bed Depth (in.)	25	26	27	26				
PA Flow (Klbs/hr)	341	353	366	353				
SA Flow (Klbs/hr)	210.4	186.7	198.9	198.7				
Opacity (%)	2.12	1.92	1.90	1.98				
Carbon Monoxide (ppm)	4	0	8	4				
Bag house (Dp inches)	3.1	3.2	3.2	3.2				
Exit gas Temperature	316	317	325	319				
Output (MWh-net)	53.85	57.29	58.06	56.40				
Soot Blowing	9:47							
Ammonia Flow (lb/hour)	0	0	0	0				
MPU Fireman	Rick Mleziva							
NOTES: B9 is found on graphic 103, turbine is on graphic 140.								
B9 supplying all extraction steam, the Diesel is not online.								

Boiler Stack Test Operating Data								
Date: April 17, 2012	Boiler: B-09		Recorded by: Thomas E. Reed					
Test: PM	Run: No. 2	Testing by: Stack Test Group, Inc.						
Methods: USEPA Methods 1, 2, 3, 4, 5, 202, 40CFR Part 60, Appendix A								
Parameter	Start	Mid	Stop	Avg. Net				
Time	10:10	11:10	12:20	2:10				
Coal Scale (A.)	5430		42082	36,652				
Coal Scale (B.)	456525		492765	36,240				
Coal Scale (C.)	245527		281543	36,016				
Total Pounds of Fuel				108,908				
Pounds of fuel per hour				50,265				
Limestone (Klbs/hr)	10.8	14.1	16.9	13.9				
Limestone Scale (lbs)	274851		302229	27,378				
MW Totals (MWh)	9116.9		9251.2	134.3				
Output (MWh-gross)	63.44	61.76	62.45	62.55				
Steam Flow (Klbs/hour)	503	477	483	488				
Percent of MCR	106%	100%	102%	103%				
Feed Water (Klbs/hr)	484	464	469	472				
Boiler Master (psig)	1464.5	1461.8	1465.3	1463.9				
Fuel Master (Klbs/hr)	49.4	50.0	50.5	50.0				
Differential Freeboard	8.9	9.2	9.5	9.2				
Bed Temperature (F)	1677	1660	1668	1668				
Bed Depth (in.)	26	28	30	28				
PA Flow (Klbs/hr)	378	366	378	374				
SA Flow (Klbs/hr)	194.2	170.2	178.7	181.0				
Opacity (%)	1.81	2.25	2.09	2.05				
Carbon Monoxide (ppm)	2	0	3	2				
Bag house (D _p inches)	3.0	3.3	4.4	3.6				
Exit gas Temperature	322	316	321	320				
Output (MWh-net)	56.54	56.48	57.52	56.85				
Soot Blowing	Yes		10:35					
Ammonia Flow (lb/hour)	0	0	0	0				
MPU Fireman	Rick Mleziva							
NOTES: B9 is found on graphic 103, turbine is on graphic 140.								
B9 supplying all extraction steam, the Diesel is not online.								

Boiler Stack Test Operating Data								
Date: April 17, 2012	Boiler: B-09	Recorded by: Thomas E. Reed						
Test: PM	Run: No. 3	Testing by: Stack Test Group, Inc.						
Methods: USEPA Methods 1, 2, 3, 4, 5, 202, 40CFR Part 60, Appendix A								
Parameter	Start	Mid	Stop	Avg. Net				
Time	12:32	1:35	14:39	2:07				
Coal Scale (A.)	45117		80996	35,879				
Coal Scale (B.)	495766		531189	35,423				
Coal Scale (C.)	284539		319725	35,186				
Total Pounds of Fuel				106,488				
Pounds of fuel per hour				50,309				
Limestone (Klbs/hr)	16.9	16.9	16.4	16.7				
Limestone Scale (lbs)	304613		332885	28,272				
MW Totals (MWh)	59262.7		59392.9	130.2				
Output (MWh-gross)	63.09	62.3	60.96	62.12				
Steam Flow (Klbs/hour)	477	485	477	480				
Percent of MCR	100%	102%	100%	101%				
Feed Water (Klbs/hr)	476	469	459	468				
Boiler Master (psig)	1465.5	1463.5	1461.3	1463.4				
Fuel Master (Klbs/hr)	50.4	50.6	49.5	50.2				
Differential Freeboard	9.2	9.2	7.9	8.7				
Bed Temperature (F)	1670	1669	1670	1670				
Bed Depth (in.)	29	27	23	26				
PA Flow (Klbs/hr)	371	369	379	373				
SA Flow (Klbs/hr)	171.5	166.5	157.3	165.1				
Opacity (%)	1.62	1.68	1.43	1.58				
Carbon Monoxide (ppm)	8	1	3	4				
Bag house (Dp inches)	4.2	3.0	3.3	3.5				
Exit gas Temperature	322	326	322	323				
Output (MWh-net)	57.95	56.60	56.09	56.88				
Soot Blowing	1:35		2:23					
Ammonia Flow (lb/hour)	0	0	0	0				
MPU Fireman	Rick Mleziva							
NOTES: B9 is found on graphic 103, turbine is on graphic 140.								
B9 supplying some extraction steam as we are transferring load to B8, the Diesel is not online.								

APPENDIX G
COAL ANALYSIS & F-FACTOR CALCULATION

LAB NO. 2012-523-1
DATE REC'D 04/25/12
DATE SAMPLED 04/19/12
SAMPLED BY CLIENT



STANDARD LABORATORIES, INC.

1530 N. Cullen Avenue
Evansville, IN 47715

MANITOWOC PUBLIC UTILITIES
P.O. BOX 1090
MANITOWOC, WI 54221

SAMPLE IDENTIFICATION

B8
PM STACK TEST
04/19/12

DATE REPORTED: 05/10/12

	% MOISTURE	% ASH	% VOLATILE	% FIXED CARBON	BTU/LBS	% SULFUR
AS REC'D	9.29	2.37	XXXX	XXXX	12901	4.70
DRY BASIS	-----	2.61	XXXX	XXXX	14222	5.18
M-A-FREE					14603	

ULTIMATE ANALYSIS

% As Received Dry Basis

Carbon	73.66	81.20
Hydrogen	3.94	4.34
Nitrogen	1.22	1.35
Ash	2.37	2.61
Sulfur	4.70	5.18
Oxygen	4.82	5.32
Moisture	9.29	

Respectfully Submitted

LAB NO. 2012-523-2
DATE REC'D 04/25/12
DATE SAMPLED 04/17/12
SAMPLED BY CLIENT



1530 N. Cullen Avenue
Evansville, IN 47715

MANITOWOC PUBLIC UTILITIES
P.O. BOX 1090
MANITOWOC, WI 54221

SAMPLE IDENTIFICATION

B9
PM STACK TEST
04/17/12

DATE REPORTED: 05/10/12

	% MOISTURE	% ASH	% VOLATILE	% FIXED CARBON	BTU/LBS	% SULFUR
AS REC'D	6.41	3.43	XXXX	XXXX	13544	4.98
DRY BASIS	-----	3.66	XXXX	XXXX	14472	5.32
M-A-FREE					15022	

ULTIMATE ANALYSIS

% As Received Dry Basis

Carbon	75.74	80.93
Hydrogen	3.94	4.21
Nitrogen	1.36	1.45
Ash	3.43	3.66
Sulfur	4.98	5.32
Oxygen	4.14	4.43
Moisture	6.41	

Respectfully Submitted

CALCULATION OF F-FACTOR
AND PARTICULATE EMISSION RATE
(Oxygen Method)
BOILER #B-28

	DRY BASIS		
	Test 1	Test 2	Test 3
E = CF (20.9/(20.9-%O ₂)	0.014	0.014	0.014
E = Pollutant Emission Rate (lb/million BTU)	0.025	0.026	0.024
C = Pollutant Concentration (lb/dscf x 10 ⁻⁶)	0.00000179	0.00000185	0.0000017
F = dscf/million BTU	9963.4	9963.4	9963.4
O ₂ = Average Oxygen Volume (expressed as percent)	6.2	6.2	6.2
F = 10 ⁶ *(3.64*%H + 1.53*%C + 0.57*%S + 0.14*%N - 0.46*%O)/GCV	9895.1	9895.1	9895.1
H = Hydrogen Content of Fuel (percent)	4.34	4.34	4.34
C = Carbon Content of Fuel (percent)	81.2	81.2	81.2
S = Sulfur Content of Fuel (percent)	5.18	5.18	5.18
N = Nitrogen Content of Fuel (percent)	1.35	1.35	1.35
O = Oxygen Content of Fuel (percent)	5.32	5.32	5.32
GCV = Gross Calorific Value of Fuel (BTU/lb)	14,222	14,222	14,222

**CALCULATION OF F-FACTOR
AND PARTICULATE EMISSION RATE**

(Oxygen Method)

BOILER #B09

	DRY BASIS		
	Test 1	Test 2	Test 3
E = CF (20.9/(20.9-%O ₂)	0.013	0.013	0.013
E = Pollutant Emission Rate (lb/million BTU)	0.018	0.018	0.017
C = Pollutant Concentration (lb/dscf x 10 ⁻⁶)	0.00000145	0.00000139	0.00000133
F = dscf/million BTU	9963.4	9963.4	9963.4
O ₂ = Average Oxygen Volume (expressed as percent)	4.5	4.5	5.0
F = 10 ⁶ *(3.64*%H + 1.53*%C + 0.57*%S + 0.14*%N - 0.46*%O)/GCV	9697.7	9697.7	9697.7
H = Hydrogen Content of Fuel (percent)	4.21	4.21	4.21
C = Carbon Content of Fuel (percent)	80.93	80.93	80.93
S = Sulfur Content of Fuel (percent)	5.32	5.32	5.32
N = Nitrogen Content of Fuel (percent)	1.45	1.45	1.45
O = Oxygen Content of Fuel (percent)	4.43	4.43	4.43
GCV = Gross Calorific Value of Fuel (BTU/lb)	14,472	14,472	14,472

Heat Input Calculations
Manitowoc Public Utilities
Manitowoc, WI
4/19/2012

Boiler #B-28

	Weight of Coal Used (Pounds)	Time (Min.)	Coal Used (Pounds/hr)	BTU/LB	Heat Input (MMBTU/HR)
Test 1	45846	126	21831.4	12901	281.65
Test 2	48003	129	22327.0	12901	288.04
Test 3	46876	127	22146.1	12901	285.71

Heat Input Calculations
Manitowoc Public Utilities
Manitowoc, WI
4/17/2012

Boiler #B-09

	Weight of Coal Used (Pounds)	Time (Min.)	Coal Used (Pounds/hr)	BTU/LB	Heat Input (MMBTU/hr)
Test 1	112942	127	53358.4	13544	722.69
Test 2	108908	130	50265.2	13544	680.79
Test 3	106488	127	50309.3	13544	681.39